

**APPLICATION OF TIMOTHY E. WALSH AND THOMAS M. HOWARD**

**CONNECTOR FOR JOINING TWO LENGTHS OF  
SHEET METAL DUCTING TOGETHER END-TO-END  
AND THE TWO PIECES OF SHEET METAL**

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# **BACKGROUND OF THE INVENTION**

## **Field of the Invention:**

The present invention relates to the class of duct and pipe joints or couplings. More particularly, the present invention relates to the subclass of particular interfaces originally in sheet form.

## **Description of the Prior Art:**

Heretofore it has been conventional to employ duct connectors, which used screws, bolts, clips, drives, and other external hardware to connect ducts end-to-end. The prior art connectors also required use of welding and metal working tools of various kinds.

These prior art techniques made installation of rectangular air conditioning ducts slow and laborious. Furthermore, in service, these connectors permitted leakage of conditioned air under pressure from air conditioning systems.

Thus, there exists a need for a duct connector that makes installation of rectangular air conditioning ducts fast and not laborious and which does not permit leakage of conditioned air under pressure from air conditioning systems.

1 Numerous innovations for duct work connectors have been provided in the prior art.  
2 Even though these innovations may be suitable for specific purposes which they address, they  
3 each differ in structure operation and/or purpose from the present invention.

4 **FOR EXAMPLE**, U.S. Patent Number 1,935,690 to Zack teaches a joint for metal  
5 duct sections comprising a sheet metal body folded to form three folds between two of which  
6 one end of a duct section is insertable and between the next two of which the end of the  
7 adjoining duct section is inserted. Projections on the two duct sections, and detachable means  
8 engaging the projections hold the duct section ends locked between the respective pairs of  
9 folds.

10 **ANOTHER EXAMPLE**, U.S. Patent Number 2,275,572 to Somers teaches a sheet  
11 metal duct of the type having a plurality of tubular sections and means for connecting the ends  
12 of the sections. The means for connecting the ends of the sections comprises a coupling  
13 formed of a plurality of bars, each of which has a longitudinally extending groove in each side  
14 edge. Cooperative means are provided on the bars for detachably connecting the ends thereof  
15 to form an endless collar. Inwardly directed shoulders are formed on the bars within the  
16 grooves.

17 **STILL ANOTHER EXAMPLE**, U.S. Patent Number 3,246,918 to Burghart teaches  
18 a joint for joining ends of separate air ducts. The joint comprises a first supported air duct  
19 having top and bottom walls with end edges, a second air duct having top and bottom walls  
20 with unsupported ends, first cleat means joining the end of the second duct top wall to the end  
21 of the first duct top wall, and second cleat means joining the end of the second duct bottom  
22 wall to the end of the first duct bottom wall. Each of the cleat means is a reversible cleat and

1 comprises a first generally planar sheet-like cleat section having first and second surfaces and  
2 first and second edges, a second generally planar sheet-like cleat section having first and  
3 second surfaces and first and second edges, the second section being generally parallel to the  
4 first section and having its first surface closely facing the second surface of the first section,  
5 a third generally planar sheet-like cleat section having first and second edges, the third section  
6 being generally parallel to the first and second sections and having a surface closely facing the  
7 second surface of the second section, a first integral sheet portion defining an outwardly  
8 projecting integral rib along the first edge of the first section generally perpendicular to the  
9 first section, a double thickness integral sheet portion comprising an outwardly projecting  
10 integral extension of the first section from along the second edge of the first section, the  
11 extension being folded over upon itself and extending downwardly to a position below the  
12 second edge of the first section and enclosing the second edge of the first section and merging  
13 with the second edge of the second section, the extension being generally perpendicular to the  
14 first section, the rib and extension being spaced from each other, generally parallel to each  
15 other, and defining an inverted channel together with the first clear section, and a joining  
16 portion joining the first edge of the second cleat section with the first edge of the third cleat  
17 section, the joining portion comprising an integral sheet portion extending in an arc of about  
18 180 degrees to define a fold merging with the first edge of the second and third cleat sections,  
19 the first and second and the second and third cleat sections closely face each other to tightly  
20 receive the wall ends of opposite ones of the ducts, the first edge of the first section and the  
21 first edge of the second section comprising a pair of lips defining a first elongated slit like  
22 opening for insertion of the end wall of a duct, the second edge of the second section and a  
23 second edge of the third section comprising of pair of lips defining a second elongated slit like  
24 opening, the top wall of the first duct having its end portion within the second opening and  
25 tightly between the second and third planar sections of the first cleat means, the top wall of the

1 second duct having its end portion overlying the end portion of the first duct top wall and  
2 received within the first opening and tightly between the first and second planar sections of  
3 the first cleat means, the first duct having its bottom wall end within the first opening and  
4 tightly held between the first and second planar sections of the second cleat means and the  
5 second duct having its bottom wall end portion overlying and overlapping the first duct bottom  
6 wall end portion and received within the second opening and tightly between the second and  
7 third planar sections of the second cleat means, and means impaling each of the cleats and the  
8 wall ends received thereby and holding the cleat sections with the wall ends tightly  
9 sandwiched therebetween.

10 **YET ANOTHER EXAMPLE**, U.S. Patent Number 3,415,543 to Keating teaches a  
11 coupling frame including a hollow channel which overlies duct or wall sections to be joined  
12 and a pair of reversely folded legs which define opposed wall receiving channels. In the  
13 preferred embodiment, the frame is rectangular and defines a chamber which overlies the  
14 junction of the duct or wall sections.

15 **STILL YET ANOTHER EXAMPLE**, U.S. Patent Number 4,558,892 to Daw *et al.*  
16 teaches a duct assembly system for joining duct sections, each having a plurality of flat  
17 intersecting walls which includes angle member connectors respectively associated with the  
18 duct walls. Each connector is generally L-shaped with one leg portion extending perpendicular  
19 to the duct wall and having an elongated channel formed therein and the other leg portion  
20 comprising two biased-together flanges adapted for frictionally receiving the adjacent duct  
21 wall edge therebetween. Each flange has elongated ridges which interlock with elongated ribs  
22 on the associated duct wall. Each duct wall edge is embedded in a mastic sealant in a trough  
23 in the associated connector. The trough has diverging sides for guiding the duct wall edge

1     thereinto. Connectors on intersecting duct walls are joined by corner members formed of sheet  
2     metal and flanged for rigidity and tight fit in the connector channels. Each corner member has  
3     flanges for gripping the channel edges of the joined connectors. Adjacent corner members on  
4     the two duct sections are joined by fasteners and a gasket may be disposed between the duct  
5     sections.

6           **YET STILL ANOTHER EXAMPLE**, U.S. Patent Number 4,941,693 to Spaude *et*  
7     *al.* teaches a connector for connecting end-to-end two spiral-wound sheet metal air ducts. The  
8     connector is an annular structure with opposite end segments, each of which presents an  
9     annular recess or groove which is open at its outer end and closed at its inner end and filled  
10    with sealing mastic. The dimension of each recess or groove transverse to the longitudinal  
11    axis of the ducts and the connector is substantially equal to the maximum thickness of the  
12    corresponding duct (*i.e.*, where its spiral rib is located), so that each duct has a snug sliding  
13    fit in the corresponding recess.

14           **STILL YET ANOTHER EXAMPLE**, U.S. Patent Number 5,195,789 to Walsh *et*  
15    *al.* teaches a slip lock connector assembly for joining end-to-end first and second flat-sided  
16    ducts made of sheet metal and has a frame like structure defined by a plurality of similar  
17    connecting members arranged in coplanar array. Each connecting member is made of pliable  
18    sheet metal bent, rolled, and molded to proper form. Each member has a flat main wall with  
19    first and second walls at opposite sides defining first and second channels. Both channels are  
20    filled with sealant material. The flat end of a side of the first duct is slipped into the first  
21    channel and secured by auxiliary fastening elements, whereby the sealant in the first channel  
22    seals the connector to the flat end of the first duct. The flat end of a side of the second duct  
23    is slipped into the second channel and sealed by the sealant therein. In addition, the wall of

1 the second channel is formed with a rolled ledge which engages with lock projections on a side  
2 of the second duct to secure the second duct to the second channel. The second channel may  
3 have a laterally extending flange to stiffen the structure of the connecting member.

4 **YET STILL ANOTHER EXAMPLE**, U.K. Patent Number 1,458,912 to Kelter  
5 teaches two ducts having substantially similar quadrangular cross sectional shapes and  
6 positioned in an end-to-end relationship. Each duct has an outer wall and a liner overlying the  
7 inner surface of the outer wall, the liner of each duct terminating in an end, the outer wall of  
8 each duct having an end portion extending beyond the end of its overlying liner, and a clip  
9 positioned between the ducts, the clip being elongate and comprising an outer fold extending  
10 longitudinally of the clip and joined at one longitudinal edge to one longitudinal edge of the  
11 outer fold and bent thereover to form a channel between the outer and middle folds, an inner  
12 fold extending longitudinally of the clip and joined at one longitudinal edge to the opposite  
13 longitudinal edge of the middle fold and bent thereover to form a channel between the inner  
14 and middle folds, a leg extending longitudinally of the clip and projecting substantially  
15 perpendicularly from the inner fold between the one longitudinal edge and the opposite  
16 longitudinal edge of the inner fold, the leg terminating in a flange spaced overlying the inner  
17 fold, the end portion of the outer wall of one duct being positioned in the channel between the  
18 outer and middle folds, the end portion of the outer wall of the other duct being positioned in  
19 the channel between the inner and middle folds, and the end of the liner of one of the ducts  
20 being fitted under the flange and over a portion of the inner fold.

21 It is apparent that numerous innovations for duct work connectors have been provided  
22 in the prior art that are adapted to be used. Furthermore, even though these innovations may

- 1 be suitable for the specific individual purposes to which they address, however, they would
- 2 not be suitable for the purposes of the present invention as heretofore described.



## SUMMARY OF THE INVENTION

**ACCORDINGLY, AN OBJECT** of the present invention is to provide a connector for joining two pieces of sheet metal together end-to-end and the two pieces of sheet metal that avoids the disadvantages of the prior art.

**ANOTHER OBJECT** of the present invention is to provide a connector for joining two pieces of sheet metal together end-to-end and the two pieces of sheet metal that is simple to use.

**BRIEFLY STATED, STILL ANOTHER OBJECT** of the present invention is to provide a connector for joining two pieces of sheet metal together end-to-end. A second wall and a first wall define a first channel therebetween, into which a ledge extends, and which lockingly receives one piece of sheet metal by virtue of at least one reverse button lock projection on a raw free end of the one piece of sheet metal snapingly engaging against the ledge. A third wall terminates in a free edge that is folded onto itself, and together with the first wall defines a second channel therebetween that lockingly receives the other piece of sheet metal by virtue of at least one reverse button lock projection on a raw free end of the other piece of sheet metal snapingly engaging against the folded free edge of the third wall.

The novel features which are considered characteristic of the present invention are set forth in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of the specific embodiments when read and understood in connection with the accompanying drawing.

## **BRIEF DESCRIPTION OF THE DRAWING**

The figures of the drawing are briefly described as follows:

- FIGURE 1** is a diagrammatic perspective view of the connector of the present invention joining two pieces of sheet metal of the present invention together end-to-end;
- FIGURE 2** is a diagrammatic cross sectional view taken along **LINE 2-2** in **FIGURE 1**;
- FIGURE 3** is an exploded diagrammatic perspective view of the connector of the present invention joining two pieces of sheet metal of the present invention together end-to-end shown in **FIGURE 1**;
- FIGURE 4** is a diagrammatic cross sectional view taken along **LINE 4-4** in **FIGURE 3**;
- FIGURE 4A** is a diagrammatic front elevational view of a connector assembly embodying the invention, shown installed on a first duct, with portions of a second duct also shown attached to the connector assembly;
- FIGURE 5** is a diagrammatic end view of a first alternate embodiment of the connector of the present invention wherein the second piece of sheet metal is formed as one-piece with the connector; and
- FIGURE 6** is a diagrammatic end view of a second alternate embodiment of the connector of the present invention wherein the second piece of sheet metal does not have the reverse button locks thereon.

## LIST OF REFERENCE NUMERALS

### UTILIZED IN THE DRAWING

1		
2		
3	<b>10</b>	connector of present invention for joining first piece of sheet metal <b>12</b> and second
4		piece of sheet metal <b>14</b> together end-to-end
5	<b>12</b>	first piece of sheet metal
6	<b>14</b>	second piece of sheet metal
7	<b>16</b>	raw free end of first piece of sheet metal <b>12</b>
8	<b>18</b>	at least one wedge-shaped reverse button lock projection on raw free end <b>16</b> of first
9		piece of sheet metal <b>12</b>
10	<b>20</b>	raw free end of second piece of sheet metal <b>14</b>
11	<b>22</b>	at least one wedge-shaped reverse button lock projection on raw free end <b>20</b> of second
12		piece of sheet metal <b>14</b>
13	<b>24</b>	joggle on raw free end <b>20</b> of second piece of sheet metal <b>14</b> , inward of at least one
14		wedge-shaped reverse button lock projection <b>22</b> on raw free end <b>20</b> of second piece of
15		sheet metal <b>14</b>
16	<b>26</b>	longitudinal center line of connector <b>10</b>
17	<b>28</b>	length of connector <b>10</b>
18	<b>30</b>	first wall
19	<b>32</b>	second wall
20	<b>34</b>	ledge
21	<b>36</b>	third wall
22	<b>38</b>	first channel defined by first wall <b>30</b> and second wall <b>32</b>
23	<b>40</b>	free edge of third wall <b>36</b>

- 1    **42**    folded free edge of free edge **40** of third wall **36**
- 2    **44**    second channel defined by first wall **30** and third wall **36**
- 3    **46**    lateral opening of first channel **38**
- 4    **48**    lateral opening of second channel **44**
- 5    **50**    other raw free end of second piece of sheet metal **14**
- 6    **52**    one continuous piece of pliable sheet metal
- 7    **54**    adhesive sealing compound material
- 8    **56**    terminal edge of second wall **32**
- 9    **58**    terminal edge of ledge **34**
- 10   **60**    fourth wall
- 11   **62**    terminal edge of fourth wall **60**
- 12   **64**    drill rail of fourth wall
- 13   **66**    flange
- 14   **68**    free edge of flange **66**
- 15   **70**    folded free edge of free edge **68** of flange **66**
- 16   **110**   first alternate embodiment of connector of present invention
- 17   **210**   second alternate embodiment of connector of present invention

## DETAILED DESCRIPTION OF

## THE PREFERRED EMBODIMENT

Referring now to the figures, in which like numerals indicate like parts, and particularly to **FIGURES 1-4**, which are, respectively, a diagrammatic perspective view of the connector of the present invention joining two pieces of sheet metal of the present invention together end-to-end, a diagrammatic cross sectional view taken along **LINE 2-2** in **FIGURE 1**, an exploded diagrammatic perspective view of the connector of the present invention joining two pieces of sheet metal of the present invention together end-to-end shown in **FIGURE 1**, and a diagrammatic cross sectional view taken along **LINE 4-4** in **FIGURE 3**, the connector of the present invention is shown generally at **10** for joining a first piece of sheet metal **12** and a second piece of sheet metal **14** together end-to-end. The first piece of sheet metal **12** has a raw free end **16** with at least one wedge-shaped reverse button lock projection **18** thereon, while the second piece of sheet metal **14** has a raw free end **20** with at least one wedge-shaped reverse button lock projection **22** thereon and a joggle **24** inward of the at least one wedge-shaped reverse button lock projection **22** thereon.

The connector **10** has a longitudinal center line **26** and a length **28** and comprises a first wall **30**, a second wall **32**, a ledge **34**, and a third wall **36**. The first wall **30** is flat and extends the length **28** of the connector **10**. The second wall **32** is flat, extends the length **28** of the connector **10**, is parallel to the first wall **30**, and defines with the first wall **30** a first channel **38** therebetween. The ledge **34** extends the length **28** of the connector **10** and inwardly from the second wall **32**, into the first channel **38**. The third wall **36** is flat, extends the length **28** of the connector **10**, is parallel to the first wall **30**, terminates in a free edge **40** that is folded

1 inwardly onto itself so as to form a folded free edge 42, and defines with the first wall 30 a  
2 second channel 44 therebetween.

3 The first channel 38 opens laterally so as to form a lateral opening 46 that lockingly  
4 receives the raw free end 16 of the first piece of sheet metal 12, by virtue of the at least one  
5 wedge-shaped reverse button lock projection 18 on the raw free end 16 of the first piece of  
6 sheet metal 12 spreading the second wall 32 away from the first wall 30 as the raw free end  
7 16 of the first piece of sheet metal 12 slips through the first channel 38 until such time as the  
8 at least one wedge-shaped reverse button lock projection 18 on the raw free end 16 of the first  
9 piece of sheet metal 12 just clears the ledge 34 causing the second wall 32 to unspread, and  
10 in so doing, causes the at least one wedge-shaped reverse button lock projection 18 on the raw  
11 free end 16 of the first piece of sheet metal 12 to be snapingly engaged onto, and lockingly  
12 captured against, the ledge 34, and in so doing, the first piece of sheet metal 12 is secured in  
13 the connector 10.

14 The second channel 44 opens laterally so as to form a lateral opening 48 that lockingly  
15 receives the raw free end 20 of the second piece of sheet metal 14, by virtue of the at least one  
16 wedge-shaped reverse button lock projection 22 on the raw free end 20 of the second piece of  
17 sheet metal 14 spreading the third wall 36 away from the first wall 30 as the second piece of  
18 sheet metal 14 slips through the second channel 44 until such time as the at least one wedge-  
19 shaped reverse button lock projection 22 on the raw free end 20 of the second piece of sheet  
20 metal 14 just clears the folded free edge 42 of the third wall 36 causing the third wall 36 to  
21 unspread, and in so doing, causes the at least wedge-shaped reverse button lock projection 22  
22 on the raw free end 20 of the second piece of sheet metal 14 to be snapingly engaged onto, and

1 lockingly captured against, the folded free edge **42** of the third wall **36**, and in so doing, the  
2 second piece of sheet metal **14** is secured in the connector **10**.

3 The first channel **38** and the second channel **44** open in opposite directions from each  
4 other so as to join the first piece of sheet metal **12** and the second piece of sheet metal **14**  
5 together end-to-end, and are offset relative to each other, and as a result thereof, requires the  
6 joggle **24** on the raw free end **20** of the second piece of sheet metal **14** to offset the second  
7 piece of sheet metal **14** so as to allow insertion of the other raw free end **50** of the second piece  
8 of sheet metal **14** into the first channel **38** of a next connector **10** without a need for field  
9 dressing.

10 The connector **10** is made from one continuous piece of pliable sheet metal **52**. The  
11 one continuous piece of pliable sheet metal **52** is galvanized sheet steel to combat corrosion,  
12 is bent, rolled, and molded to form the connector **10**, and has a thickness that ranges from  
13 eighteen to twenty-four gauge. Alternatively, the connector **10** is made from extruded plastic.

14 The connector **10** further comprises adhesive sealing compound material **54** that is  
15 highly viscous, such as that manufactured by Duro-Dyne and known as Ducklock Sealant type  
16 DLS. The adhesive sealing compound material **54** fills, and adheres to, the first channel **38**  
17 and adheres to the raw free end **16** of the first piece of sheet metal **12** so as to seal the raw free  
18 end **16** of the first piece of sheet metal **12** in the first channel **38** against leakage of a material  
19 flowing along the first piece of sheet metal **12**. The adhesive sealing compound material **54**  
20 further fills, and adheres to, the second channel **44** and adheres to the raw free end **20** of the  
21 second piece of sheet metal **14** so as to seal the raw free end **20** of the second piece of sheet

1 metal 14 in the second channel 44 against leakage of a material flowing along the second piece  
2 of sheet metal 14.

3 The second wall 32 is one-piece with the first wall 30, is bent from one longitudinal  
4 edge of the first wall 30 to fold thereover in a direction towards the other longitudinal edge of  
5 the first wall 30, is slightly spaced from one side of the first wall 30 so as to allow the first  
6 channel 38 to be narrow, and terminates in a terminal edge 56. The terminal edge 56 of the  
7 second wall 32 is disposed in close proximity to, and to one side of, the longitudinal center  
8 line 26 of the connector 10. The ledge 34 extends perpendicularly inwardly from the terminal  
9 edge 56 of the second wall 32 to a terminal edge 58 which is slightly spaced from the first  
10 wall 30.

11 The third wall 36 is one-piece with the first wall 30, is bent from the other longitudinal  
12 edge of the first wall 30 to fold thereunder in a direction towards the one longitudinal edge of  
13 the first wall 30, and is slightly spaced from the other side of the first wall 30 so as to allow  
14 the second channel 44 to be narrow. The folded free edge 42 of the third wall 36 is disposed  
15 in close proximity to, and to the other side of, the longitudinal center line 26 of the connector  
16 10.

17 The connector 10 further comprises a fourth wall 60. The fourth wall 60 is flat,  
18 parallel to the first wall 30, the second wall 32, and the third wall 36, and extends from the  
19 terminal edge 58 of the ledge 34 to a terminal edge 62 which is disposed in substantial  
20 alignment with the folded free edge 42 of the third wall 36.



1           The fourth wall 60 has a drill rail 64. The drill rail 64 of the fourth wall 60 extends the  
2 length 28 of the connector 10 and prevents a self-tapping sheet metal screw (*not shown*) being  
3 screwed into the fourth wall 60 from skipping thereacross. The self-tapping sheet metal screw  
4 (*not shown*) is screwed into the fourth wall 60, the first piece of sheet metal 12, the first wall  
5 30, the second piece of sheet metal 14, and the third wall 36 if required in order to comply to  
6 a local building code.

7           The connector 10 further comprises a flange 66. The flange 66 structurally stiffens  
8 the connector 10, is flat, and extends outwardly from the terminal edge 62 of the fourth wall  
9 60, in a direction away from the first wall 30, the second wall 32, and the third wall 36, to a  
10 free edge 68. The free edge 68 of the flange 66 is folded onto itself in a direction away from  
11 the ledge 34 so as to form a folded free edge 70 that further structurally stiffens the connector  
12 10 while eliminating a sharp edge. The flange 66 has a height that is directly proportional to  
13 the length 28 of the connector 10, and is in a range of approximately  $\frac{3}{8}$  inches to  
14 approximately  $1\frac{3}{8}$  inches.

15           As shown in **FIGURE 4A**, which is a diagrammatic front elevational view of a  
16 connector assembly embodying the invention shown installed on a first duct, with portions of  
17 a second duct also shown attached to the connector assembly, four connectors 10 are disposed  
18 at right angles to each other in a coplanar array to define a four-sided frame-like structure for  
19 joining the first piece of sheet metal 12 and the second piece of sheet metal 12 together end-to-  
20 end when each of the first piece of sheet metal 12 and the second piece of sheet metal 14 is a  
21 four-sided duct.

1           **FIGURE 4A** is illustrative of how four of the connectors **10** can be used to join a pair  
2 of four-sided ducts together end-to-end. It is to be understood, however, that any number  
3 sided ducts can be joined together end-to-end by merely utilizing a corresponding number of  
4 the connectors **10**, wherein a connector **10** is utilized for each side.

5           A first alternate embodiment of the connector **110** of the present invention can best be  
6 seen in **FIGURE 5**, which is a diagrammatic end view of a first alternate embodiment of the  
7 connector of the present invention wherein the second piece of sheet metal is formed as one-  
8 piece with the connector, and as such, will be discussed with reference thereto.

9           The connector **110** is similar to the connector **10**, except that the second channel **44** is  
10 eliminated, and as a result thereof, the third wall **36** abuts directly against the other side of the  
11 first wall **30**. Additionally, the folded free edge **42** of the third wall **36** is eliminated, and the  
12 free edge **40** of the third wall **36** is not free, but rather extends as the second piece of sheet  
13 metal **14**.

14           A second embodiment of the connection **210** of the present invention can best be seen  
15 in **FIGURE 6**, which is a diagrammatic end view of a second alternate embodiment of the  
16 connector of the present invention wherein the second piece of sheet metal does not have the  
17 reverse button locks thereon, and as such, will be discussed with reference thereto.

18           The connector **210** is similar to the connector **10**, except that the at least one wedge-  
19 shaped reverse button lock projection **22** on the raw free end **20** of the second piece of sheet  
20 metal **14** is eliminated.

1           It will be understood that each of the elements described above, or two or more  
2 together, may also find a useful application in other types of constructions differing from the  
3 types described above.

4           While the invention has been illustrated and described as embodied in a connector for  
5 joining two pieces of sheet metal together end-to-end and the two pieces of sheet metal,  
6 however, it is not limited to the details shown, since it will be understood that various  
7 omissions, modifications, substitutions and changes in the forms and details of the device  
8 illustrated and its operation can be made by those skilled in the art without departing in any  
9 way from the spirit of the present invention.

10           Without further analysis, the foregoing will so fully reveal the gist of the present  
11 invention that others can, by applying current knowledge, readily adapt it for various  
12 applications without omitting features that, from the standpoint of prior art, fairly constitute  
13 characteristics of the generic or specific aspects of this invention.